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# THE MANAGEMENT OF VEGETABLE GERMPLASM COLLECTIONS[a]

Liwayway M. Engle

Asian Vegetable Research and Development Center
P.O. Box 42, Shanhua, Tainan, Taiwan, R.O.C.

## Introduction

Vegetalbes makeup a complex crop group. Vegetables in the broad sense belong to several families of plants, including legumes and tubers, Easily a list of vegetable species can run into the hundreds. This is not surprising considering that 1,500 wild species may have been involved in the evolution of vegetable species (Grubben, 1977). Many of these species are annuals whose leaves, stems, immature flowers, fruits, seeds, roots or tubers are consumed alone or in combination with other foodstuff usually as supplementary source of vitamins, minerals, fibers, additional proteins and calories.

The recognition of the importance of vegetables in proper nutrition and their potential to raise incomes suggest that vegetable production will increase especially in developing countries where consumption is estimated to be only half of that in developed countries (Grubben, 1977).

Vegetables are in various stages of domestication. The continuum starts from wild populations harvested when needed and includes semi-wild partially cultivated as well as varieties of traditional agriculture and extends to highly specialized horticultural varieties.

As in other crop species, the conservation of vegetable genetic resources for preservation and use in crop improvement is essential 1) if we are to enhance agricultural productivity especially in rural and urban areas of developing countries and 2) if we are to answer future needs.

The importance of vegetable genetic resources in present vegetable genetic improvement programs is reflected in the amount of materials that

the Asian Vegetable Research and Development Center (AVRDC) has distributed (Tables 1 and 2). In 1992 alone, 85 countries and territories received AVRDC vegetable germplasm. A total of 19,283 samples were distributed outside of the Center. Within the Center, 4,247 samples were utilized. The annual increase over the last two years was 4,000 samples (AVRDC, 1992, 1993). Samples distributed included not only the principal crops but also non-principal crops like minor legumes, amaranths, etc. However, an assembly of vegetable germplasm is meant to answer not only our present but also our future needs.

This paper will present strategies in the management of vegetable germplasm collections for use in preservation and distribution. It is based mainly on the experiences of AVRDC.

Table 1. External seed distribution of germplasm and breeding lines in 1992.

| Country | No. of samples | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Soy-bean | Mung-bean | To-mato | Chinese cabbage | Pepper | Sweet potato | Others | Total |
| Thailand | 2,176 | 2,298 | 2,025 | 371 | 419 | - | 266 | 7,555 |
| India | 15 | 115 | 386 | 1 | 460 | 52 | 1 | 1,030 |
| Philippines | 25 | 352 | 70 | 18 | 485 | 20 | 1 | 971 |
| Taiwan | 16 | 7 | - | 3 | 56 | 644 | 64 | 790 |
| Peru | - | - | - | 2 | - | 697 | - | 699 |
| USA | 40 | 67 | 135 | 2 | 182 | 56 | 167 | 649 |
| Korea (s.) | 199 | 11 | 352 | - | 57 | - | 5 | 624 |
| Tanzania | - | 40 | 331 | 28 | - | 100 | - | 499 |
| Sri Lanka | 38 | 14 | 136 | - | 277 | 25 | - | 490 |
| Fiji Islands | 20 | 40 | 369 | 3 | - | - | - | 459 |
| Others[a] | 811 | 1,259 | 1,677 | 321 | 1,052 | 345 | 52 | 5,517 |
| Total (85) | 3,340 | 4,203 | 5,508 | 749 | 2,988 | 1,939 | 556 | 19,283 |

[a] Includes 75 countries and territories.

Table 2. Internal seed distribution at AVRDC in 1992.

| Department | Soy-bean | Mung-bean | To-mato | Chinese cabbage | Pepper | Egg-plant | Others | Total |
|---|---|---|---|---|---|---|---|---|
| Analytical Lab | 1 | 1 | - | - | - | - | - | 1 |
| Entomology | 17 | 2,038 | 1 | - | 250 | 101 | - | 2,407 |
| Pathology | 258 | 107 | 421 | 191 | 439 | 47 | 11 | 1,474 |
| Physiology | - | 2 | 11 | - | - | - | - | 13 |
| Plant Breeding | 22 | 6 | 14 | 30 | 61 | - | - | 133 |
| Training | - | - | 24 | 25 | 14 | - | 12 | 75 |
| Crop Management | - | - | 20 | 1 | - | 45 | 2 | 68 |
| Country Program | - | - | - | - | - | 45 | 16 | 61 |
| GRSU | - | - | - | - | 15 | - | - | 15 |
| Total | 298 | 2,153 | 491 | 247 | 779 | 238 | 41 | 4,247 |

## AVRDC and It's Mission

The management of a germplasm collection is made much easier if the aims and objectives of the unit responsible for it are clearly stated. A genebank which is part of an institution clearly must be committed to the mission of that institution.

AVRDC's mission for the 1990's is "to enhance the nutritional well-being and raise incomes of poor people in the rural and urban areas of developing countries through improved varieties and methods of vegetable production, marketing and distribution, which take iinto account the need to preserve the quality of the environment" (AVRDC, 1992). To attain this goal, AVRDC has identified three broad categories of activities, one of which is the "conservation and characterization of vegetable genetic resources and their use to develop improved varieties." The germplasm collection of the Center is therefore geared towards preservation and utilization.

## The Scope of the Collections

Table 3 shows the status of the AVRDC vegetable germplasm collec-

tion. The AVRDC collections represent a unique and invaluable regional and world resources of vegetable. We have assembled one of the largest vegetable genebanks and has accepted responsibility for the world base collection of mungbean and the global duplicate collection of pepper. The collection was assembled primarily because of the need for germplasm in crop improvement programs of both the Center and that of NARS (National Agricultural Research Systems).

Table 3. The AVRDC germplasm collections as of 30 September 1993.

| Crop | No. of accessions |
|---|---|
| Priority crops: | |
| Sorybean (regional) | 13, 603 |
| Tomato | 6, 629 |
| Pepper | 6, 363 |
| Mungbean (regional) | 5, 737 |
| *Brassica* | 1, 421 |
| Eggplant | 564 |
| *Allium* | 327 |
| Subtotal | 34, 644 |
| Other crops: | |
| Yardlong bean and cowpea | 1, 600 |
| Black gram | 452 |
| *Phaseolus* bean (including lima) | 450 |
| *Luffa* | 229 |
| Pea | 207 |
| *Cucumis* | 206 |
| *Abelmoschus* | 187 |
| Lablab bean | 161 |
| *Cucurbita* | 148 |
| *Benincasa* | 126 |
| Others | 919 |
| Subtotal | 4, 685 |
| TOTAL | 39, 329 |

A utilization-oriented collection, whether to serve present needs or that of the future, should include as wide a range of diversity as possible.

Vegetable breeders and other researchers require genetically diverse materials to be able to continuously develop improved types and varieties that can face the challenge of an environment that is both evolving and becoming limiting. A genetically diverse genepool is the raw material from which the plant breeder will mold new varieties. Therefore, the availability of useful genes in the collection determine the success of the plant breeder in fashioning out a variety with specific characteristics. The more diverse a genepool is, the higher is the probability that it would contain the desirable genes.

Although AVRDC's collection of vegetable germplasm is considered one of the most extensive in the world, there are still obvious gaps. Even for its principal crops, the collection is deficient in members of the secondary and tertiary genepools as well as other members of the primary genepool. Representation of non-principal, but nevertheless regionally important, vegetable crops range from inadequate to practically non-existent. Therefore, to be able to accomplish its objectives fully, AVRDC is stepping up its germplasm acquisition and collecting efforts. There is an added urgency to undertake these efforts in developing countries such as those in Southeast Asia because of the increasing threat of genetic erosion (Sastrapradja and Kartawinata, 1975). The pressures of development, increasing population and vigorous marketing of modern cultivars by seed companies are resulting in the rapid disappearance of old local varieties and the old species which may carry valuable genetic characteristics.

In recognition of the need for collecting in Southeast Asia, AVRDC stepped up its exploration activities in Malaysia, Philippines, Thailand and Indonesia as part of a JICA-supported project "Conservation, Evaluation and Utilization of Vegetable Genetic Resources - A Collaborative Network Project for Southeast Asia." To implement the project, AVRDC sought the collaboration of national institutions in the participating countries. A series of consultation was held with the national scientists to map out the strategy that will be followed in the collecting expeditions. Where available (e.g. Philippines and Indonesia), a survey of past effort and current status of germplasm resources was done. Priorities in species and geographic area were set and the route mapped out. In many of the expeditions, the strategy followed was to visit the fresh vegetable market in the morning to survey what vegetables were found in the area. To make sure that samples of diverse material found in the market were represented in the collection, a few fruits of eggplants, pepper, gourd, etc., were bought. Vendors were interviewed as to sources of materials. Afterwards, the local guide

accompanied the collecting team to vegetable-growing areas or to specific home gardens and farmlands. Most of the collected materials came from backyards or home gardens followed by collections from farmlands. Many could be classified as primitive cultivars or landraces and farmer's selection. Some wild species were also collected. As a result of the collecting expeditions, a total of 3,880 samples were collected (Table 4). Collected materials were shared: half was left in the country where they were collected and half was brought to GRSU. This project is the first step towards AVRDC's longterm objective of assembling a comprehensive germplasm collection of its principal crops, as well as the other major vegetable crops including indigenous species. While initially efforts have been concentrated on the principal crops, the Center recognizes that an international effort on vegetable should try to cover other vegetable crops species as well, taking into consideration the priorities of national programs especially in developing countries.

Table 4. Vegetable germplasm collected in Southeast Asia in 1990-92.

| Country | No. of species[a] | Total no. of samples | | | Total |
|---|---|---|---|---|---|
| | | 1990 | 1991 | 1992 | |
| Malaysia | 28 | 448 | - | - | 448 |
| Philippines | 45 | - | 994 | 491 | 1485 |
| Thailand | 59 | - | - | 1974 | 1947 |
| Total | | 448 | 994 | 2483 | 3880 |

[a] Includes only those that have been properly identified.

However, for the collection to be meaningful and useful, it has to be grown, multiplied, carefully described, evaluated, stored, and documented.

## Seed Increase

**Quantity of seeds to produce.** New introductions frequently arrive with insufficient quantity of seeds to be directly stored for preservation. This is especially true of vegetable species collected from home gardens

and wild populations where only a few mature fruits can be collected. At least one cycle of seed multiplication is needed to produce sufficient and viable seeds for preservation and distribution.

It is best to produce large quantities of seed sufficient for preservation and distribution in as few cycles as possible. Frequent regeneration of seeds is not only costly but may also result to questionable genetic fidelity possibly due to mechanical errors, genetic drift when the sample size is small as well as genetic shifts caused by loss of unadapted genotypes (Breese, 1989).

For genetically uniform material, the acceptable size is 1,000 viable seeds within the accession and the preferred is 1,500 to 2,000 viable seeds (IBPGR, 1993). The recommended amount for heterogeneous material is 12,000 with 4,000 as minimum. At AVRDC, the practice is to produce at least 20,000 seeds per accession. This quantity is divided into two groups: 4,000 or 12,000 for the base collection under longterm storage condition of homogeneous and heterogeneous accessions, respectively, and the remainder for the active collection under medium-term preservation. To produce the target amount of seeds, 30 plants of each accession need to be established if the accession is uniform. For a heterogeneous population the number of plants used in seed increase should be sufficient to preserve its genetic composition. In cases where a sample showing distinct morphologic variants, e.g., red versus yellow mature fruits, is separated into two accessions, a second planting may be necessary to meet the required amount of seeds.

Wild species pose a problem in seed production. Supplementary hand pollination or use of insect vectors may be necessary to ensure that the desired amount of seeds is produced.

As in the collecting effort, AVRDC has taken the strategy of involving national programs in the multiplication of germplasm in its collection. Newly collected materials are multiplied in the country where they were collected. These circumvents the problems of adaptation, quarantine and cultural management of indigenous crop species. It also allows the multiplication of large numbers of accessions in a short time. Furthermore, there is the added advantage of local staff being able to immediately evaluate the potential of the materials. The Center has also sought the cooperation of countries with strong genetic resources programs in the multiplication of some of its collection: pepper multiplication in collaboration with the National Plant Genetic Resources Laboratory of the Philippines and soybean multiplication with Kasetsart University in Thailand. Recently,

AVRDC and the National Plant Genetic Resources Center of the Republic of China embarked on a joint germplasm multiplication project. Such cooperative effort speeds up the multiplication of new introductions. Seeds produced are shared between AVRDC and the collaborating institution.

Preserving genetic structure. The seed increase operations consider the need to preserve the genetic structure of the original population. Since the AVRDC collections include both self-pollinated and cross-pollinated species, seed increase procedures vary. In any case, to preserve the genetic integrity of each population, cross pollination between different accessions is prevented.

Self pollination in some species(pepper, tomato, soybean, mungbean ) ensures that cultivars and landraces are quite uniform. However, varying degrees of natural cross pollination has been known to occur, even in prodominantly self-pollinated species. This can be as high as 91% in pepper (Tanksley 1984) and 0.2 to 47% in eggplants (Quagliotti, 1979). The degree of cross pollination is influenced by distance of plants, wind direction and insect activity with the last contributing the most to cross pollination (Murthy and Murthy, 1962: Francheschetti, 1972). Therefore, peppers and eggplants are multiplied under insect-proof nylon net cages to prevent the entry of insects that may cause cross pollination. A row between plots is left vacant to separate accessions. Furthermore, plants are staked and pruned if necessary to prevent intermingling of branches. These procedures also minimize the possibility of mixing fruits harvested from adjacent plost.

Selfing can be greatly increased by hand pollination but it is too tedious and therefore, resorted to only in special cases, e.g. low seed producers.

For naturally cross-pollinating species like onion and *Brassica,* each accession is enclosed in one net cage. Insect pollinators are released inside the cage to enhance pollination.

The use of net cages has posed several problems. Aside from being expensive and laborious to construct, the shading that results affects the growth of the plants and may distort characterization data. The environment inside the net cage is also so favorable to mites that severe infestation is frequent and often difficult to control even with repeated spraying of miticides. On the other hand, growing in net cages results in the exclusion of insects that can cause damage to the fruits, e.g. fruit borer that would cause reduced seed yields as well as reduced seed vigor (Krishnasamy, 1990).

Our national partners also practice controlled pollination in okra, *Momordica* and *Cucumis,*

Some accessions show a great amount of phenotypic variation and although other accessions may look uniform based on morpho-agronomic traits, they may carry hidden heterogeneity (Quagliotti et al., 1972: Pickersgill, 1986). In pepper, our data show that out of 2,118 accessions characterized 60% can be considered as homogeneous and only 6% as highly heterogeneous. An inherently heterogeneous population is harvested as a bulk while populations where distinct variants can be recognized are divided into sub-accessions.

## Characterization

Systematic characterization using morpho-agronomic characteristics begin with the first seed increase. Such characterization data not only provide information on the potential utility of the accession but serve as identifying information that can be used to check on the correct identity of the accession during regeneration. In addition characterization data can be used to evaluate the extent of diversity in the collection and identify potential duplicates. Characterization is usually done based on the IBPGR set of descriptors. Morpho-agronomic characterization is now complemented with biochemical characterization (e.g. capsaicin and sugar content in pepper, protein and starch in mungbean and SDS-PAGE of seed proteins).

As in collecting and seed increase, AVRDC has sought the collaboration of NARS. To strengthen cooperation, training of nationals in vegetable germlasm management became an integral part of the collaborative projects.

## Preservation of Germplasm

The preservation of assembled germplasm is the core of genetic conservation (Chang, 1985). For vegetable species with orthodox seed, seed preservation is the most efficient means of maintaining large numbers of accessions and making them available for distribution.

The goal in seed preservation is to maintain genetic integrity of the population and to maximize the longevity of the stored seeds at minimal cost. Longevity is affected by two factors: the status of the seeds before entry into storage and the conditions surrounding the seeds during storage.

Processing and handling seeds for preservation. The aim of preservation is maintenance of high seed viability. High viability not only helps maximize the possibility of an adequate number of healthy vigorous seedlings being established, but also minimizes the risk of genetic damage that have been observed in several instances (Ellis, 1991) Many national genebanks consider loss of seed viability during storage one of their most serious problems, even though some of them have good storage facilities. It appears that improper pre-storage processing may be the cause of such rapid loss of viability (Engle and Chang 1991).

Precautions during processing and handling are not only meant to maintain high viability but also to avoid mechanical mixtures.

Harvesting. Harvested fruits are transported and dried in net bags to minimize accidental mixing of different accessions. Each accession is processed separately from the others.

One of the factors that affect longevity of stored seeds is the quality at harvest. Seed should therefore be harvested at stage of highest quality Reccently, experiments by Demir and Ellis (1992)contradict the widely accepted hypothesis of Harrington (1972) that a seed attains its highest quality (i.e., viability and vigor and therefore storability) at physiological maturity and that deterioration as a result of aging starts thereafter. Their experiments showed that in *Capsicum annuum,* maximum potential longevity was achieved 63 to 65 days after anthesis. This is 10 to 12 days affter mass maturity that they defined as the end of the seed-filling phase. Similar results in tomato led them to conclude that delayed harvesting results in little or reduction in seed quality in those seed crops in which seed m.c. is maintained naturally within fruits at values approaching those of fully imbibed seeds.

Other studies show that in both pepper and eggplant, better quality seed is obtained from a slightly advanced harvest than from a delayed harvest. For "Tabasco" type pepper (*C. frutescens* ), germination was greater and faster in red fruits harvested early than in immature orange fruits or those harvested post red mature in the growing season (Edwards and Sundstrom, 1986). Some seed producers leave the fruit on the plant until the abscission layer just behind the calyx is fully developed. However, over-ripe fruits should be avoided. In domesticated peppers which lack dormancy, the seeds may germinate within the moist interior of the fruit while it is still on the mother plant Such pregerminated seeds will be inviable when dried for storage (Pickersgill, 1986).

In eggplant, the germinability of seed occurs 40 days post anthesis

on the plant and increased germinability can be observed after 20 days post harvest ripening at room temperature applied to the fruit harvested 40 days after anthesis. When 100 seeds fresh and dry weight approach maximum values, germination rises abruptly from below 10% to above 80% within a very short period (Osman, 1989).

Leaving the seeds in the fruit for month after harvesting before removing them greatly increases the germination percentage in pepper although 1000 seed weight remains practically unchanged. The minimum post-harvest ripening time that can be considered effective is 20 days. On the other hand, it is worth prolonging the post-harvest ripening period to 30 days (Quagliotti, 1977). In 'Tabasco' pepper optimum post-ripening occurred after 21 days at 25℃ (Edwards and Sundstrom, 1986).

Seeds for preservation should be free from injury, surface infestation by microbes, or insect infestation. In addition, they should be harvested from plants that have not suffered stress due to water deficit, water excess, or nutritional deficiency in the field.

Seed-borne mycoflora has been described in several publications. Among seed-borne mycolflora, *Fusarium moniliforme* caused 6 to 8% loss in germination of pepper seeds (Hashmi, 1989). Pepper seed infected with *Colletotrichum* spp. often has poor germination or viability (Grover and Bansal, 1970).

Seed extraction. For large-fruited and low yielding accessions of pepper, eggplant and tomato, the fruits are usually split open with a knife the seeds extracted manually.

Hot peppers cause a big problem during extraction. Capsaicinoids can irritate the hands of those who do the extraction manually and indirectly the eyes, nose, and other sensitive tissues of the body. Dried fruits when processed produce highly irritating fine particles. Even fresh fruits in large quantities release fumes that irritate the lining of the nose and cause watery eyes. Many workers find it uncomfortable to wear gloves and masks when extracting seeds. They prefer to work outside the building or to use fans that can minimize the discomfort caused by the strong fumes. For sensitive hands, we have tried dipping hands in starch milk and soapy water after work. Starch seems to alleviate the discomfort. A mild solution of Chlorox has also been suggested (Poulos, personal communication )but is also harsh on sensitive skin. Doing the extraction inside table top cabinets with fume absorbers may help.

For small-fruited and high yielding accessions of pepper, a meat grinder can be used to cut the fruits into small pieces and the seeds

collected by water extraction (Tay, 1989.) Alternatively, the fruits inside the net bags can be threshed in water by trampling. The seeds are then washed clean of the accompanying pulp. During washing underdeveloped seeds usually float and can be removed.

Eggplant fruits are softened by beating or rolling for easier extraction. Seeds can then be manually separated from the pulp and washed clean with water.

At every step, care is exercised to minimize deterioration and mechanical damage to the seeds or mixtures.

Drying seeds. seed moisture content (m.c.) is one of the principal factors in determining seed longevity Lowering the moisture content of seeds result in improved seed longevity (Zhang and Tao, 1989; Ellis et al., 1989, 1990: Vertucci and Roos, 1990).

A three to seven percent moisture content depending on species is now recommended (IBPGR, 1993)

Emphasis on lowering seed m.c. to below 10% and the availability of free solar energy has prompted many to sun-dry or to use mechanical drying temperatures that exceed 40 ℃ (Engle and Chang, 1991). This could lower longevity of seeds. The use of heat at 35 to 45 ℃ is known to result in seed deterioration, in some vegetable seeds (Tao, 1988). Experience at AVRDC reveals that temperature of cement floors exposed to the sun can attain temperatures of 42 ℃ even on a cool-dry day (min 14.6 ℃ ) 48% RH, max 25 ℃ , 98% RH ambient conditions). IBPGR recommends that seeds are best dried in a drying room maintained at 15 ℃ and 10 to 15% RH with good circulation. At AVRDC, this condition is attained with the use of a sorption type air dehumidifier with refrigeration to lower the temperature and remove heat generated by the air dehumidifier. The seeds in net bags are placed in open trays inside the drying room for two weeks to dry down to at least 8% m.c.

More recently drying to less than three percent is recommended for some oily seeds (Ellis et al., 1990). It is not known if such ultra dried condition would provide added benefit to the preservation of pepper of eggplant seeds.

Another method is to use silica gel for drying. Seeds are placed with silica gel in a closed container. The seeds are kept in porous bags to separate them from the silica gel. Depending on species, seed m.c. can be lowered to three to seven percent within a month. A 1:1 seed to silica gel ratio (by weight) is generally used (Zhang and Tao, 1989).

Freeze-drying has been reported as another method to lower seed

moisture to the two to five percent range by avoiding potential damage due to heat and over desiccation. Seed storability at warm temperatures may be improved by this technique (Woodstock et al., 1983).

Packaging. Packaging is done to keep each accession separate, to prevent contamination of the seeds from insects and diseases and to minimize absorption of water by the dried seeds.

We find the use of aluminum polyethylene envelopes (AL-PE) convenient for both the base and active collection. Seeds for distribution are packed in AL-PE envelopes in 50-seed quantities. This allows the retrieval of a specified amount of seeds of each accession without opening and closing containers. It also provides protection from absorption of moisture by the seeds due to inadequate dehumidification of the cold store and during transport.

Storage conditions. In all its undertakings, GRSU strives to meet scientifically designed standards and recommendations set by IBPGR.

As a guide, the Preferred Standard for long-term seed storage-18℃ (Cromarty et al., 1985) is used.

For medium-term storage the temperature ranges from 0 to 10℃, RH from 15 to 50%, and seeds are stored in fairly airtight containers. The projected seed longevity ranges from 10 to 30 years or longer. It is a common experience that the required temperature is easy to attain if RH is not considered. However, maintenance of a constant 45% RH in cold stores is a big headache especially in the tropics. Shifting to airtight containers such as aluminum foil bags will allow working within a narrow range of temperature and a wider range of RH. The 1993 proposal is for storage conditions to be such that viability of accessions remains above 65% for 10 -20 years (IBPGR, 1993).

Recently, Benson (1990) assessed the rold of oxidative stress and free radical-mediated damage in the safe conservation of plant genetic resources as well as the possible effects of anti-oxidants and recovery/ repair mechanisms.

Preservation *in-vitro* and in field genebanks. We are fortunate that most vegetables have orthodox seeds and only a few of them have to be multiplied by vegetative means. Among the principal crops of AVRDC, the *Alliums* need to be preserved *in-vitro* and in field genebanks.

## Monitoring

To ensure that seed storage conditions are maintained at desired

levels, regular monitoring is required. Seed m.c. and viability need to be tested before sealing and over time during storage. Temperature and RH in the storage rooms need to be monitored as well. The amount of seed in store should be monitored especially for active collections that are used for distribution purposes. The amount of seed in store and seed viability are two factors that are considerd in deciding when regeneration of seed lots should be done.

Roberts (1975) has suggested that when seed viability drops to 85%, regeneration is warranted. However, for some crops, high initial seed viability is difficult to attain. For example initial viability testing in pepper has shown that only about 75% of the accessions tested have initial percentage germination higher than 85 (AVRDC, 1992). The consideration of this fact in the new recommended standard for genebanks (IBPGR, 1993) is most welcome. Regeneration is now recommended when viability falls to 85% of the initial value.

Regeneration and viability monitoring are two of the most laborious, time consuming and expensive activities in germplasm conservation. Regeneration becomes formidable when the collection is a large one. In the case of viability, monitoring methods used routinely are destructive so seeds that have been painstakingly multiplied have to be sacrificed during this activity. More practical approaches such as the adoption of the core collection concept (Frankel and Brown, 1984) during regeneration and the use of check varieties or clusters (AVRDC, 1992) in monitoring viability may have to be considered. The use of non-destructive methods is another possibility.

## Enhancing Utilization

It has been repeatedly said that evaluation and utilization have not kept pace with the collection activities: in Southeast Asia by the Regional Committee for Southeast Asia or RECSEA (Singh and Chomchalow, 1984).

AVRDC recognizes that the conservation, enhancement and wide distribution of plant germplasm is one domain where the comparative advantage of international centers is most profound and, probably most lasting. AVRDC therefore sees as one of its key global roles the conservation and free movement of vegetable germplasm to whoever can make good use of them. The center sees itself as a steward for such genetic resources and commits itself to their free and unrestricted distribution (AVRDC's 5-year Plan).

To enhance utilization, it is necessary to have a large active collection for distribution purposes. The AVRDC tomato collection has already been described as the largest and most comprehensive active collection of tomato germplasm in the world. GRSU's goal is to complement its base collection with a dynamic active collection.

In addition to having enough seeds for distribution, utilization can further be encouraged if evaluation data is available. Morpho-agronomic characterization is usually routinely done by genebank staff during multiplication for long-term storage. On the other hand, evaluation for traits of immediate importance to breeders (e.g. resistance to pests, diseases and abiotic stresses, improved quality, etc.) are best done with the participation of researchers from several disciplines (e.g. entomologists, pathologists, virologists, physiologists, chemists, etc.). In this way, invaluable genepools that can be channeled into breeding programs will be identified.

## Safeguarding Seed Health

An AVRDC Seed Health Committee oversees the formulation and implementation of appropriate seed health practices in the germplasm and seed resources unit. Close interaction with the host country's quarantine authorities ensure that our practices meet and the national phytosanitary standards (AVRDC, 1992).

Newly collected materials are planted in post-entry quarantine screenhouses. And for vegetatively propagated materials, the policy is to distribute *in-vitro* materials that have undergone a virus elimination and virus indexing procedure.

## The Challenge of the Future

New technologies are fast emerging. Techniques in molecular biology are now finding application in the management of germplasm. RAPD and RFLP will soon be routinely used in accession identification and characterization of genetic diversity in populations. Hopefully, they can also anwer some of the questions regarding the occurrence of genetic drift and shifts in genebanks. Statistical procedures are being used to make the task of the genebank more manageable as in the formation of core collections. Computers are cheaper, more powerful and easily available even in developing countries.

But even while such new technologies are attracting attention,

classical seed physiology studies still need to be done on some crop species, Non-destructive procedures for viability determination still need to be established.

## Conclusion

From the above it can be seen that the management of vegetable germplasm for use in preservation and distribution encompasses a web of complex interrelated activities. Many of the procedures and conditions followed are based on general precepts on preservation of germplasm. Only a few are based on actual research and data obtained.

The stringent requirements for preservation of germplasm necessitate the availability of facilities and funds designed for long-term operation as well as trained and dedicated personnel.

Genetic erosion due to loss of viability can be serious in the maintenance and storage of germplasm. Such loss is demoralizing after all the effort, risk, and cost of launching a well-planned collecting expedition, and documentation of the collections. Appropriate handling, storage procedures and management are necessary to preserve the genetic diversity gained through collection.

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